Variation in Scales Sampled from Different Body Areas of Sockeye Salmon Yearlings *(Oncorhynchus nerka)*

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VARIATION IN SCALES SAMPLED FROM DIFFERENT BODY AREAS OF SOCKEYE SALMON YEARLINGS (*Oncorhynchus nerka*)

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ABSTRACT

Bilton, H. T. 1984. Variation in scales sampled from different body areas of sockeye salmon yearlings (Oncorhynchus nerka). Can. Tech. Rep. Fish. Aquat. Sci. 1297: 7 p.

Scales were removed from 15 body areas from each of three Babine Lake yearling sockeye. Five scales from each of three areas were examined microscopically. The radius of each scale was measured and the number of circuli of each was counted. Average scale radius and number of circuli on scales from each body area were computed. The results indicated considerable variation both in scale radius and circulus number among scales from the various body areas. Scales from areas just above the lateral line were the largest in size and had the most circuli. Of the areas just above the lateral line the greatest scale size and circulus number occurred midway between the insertion of the dorsal fin and the origin of the adipose fin. Scales from areas near the dorsal and ventral surfaces of the fish had smaller scales and fewer curculi. Those from the dorsal surface had the smallest scales of all. The body area with the largest scales probably provides the most complete record of age and growth of the fish. It is therefore important that scales only from this area are used in studies of this nature.

Key words: sockeye, yearling, scale, variation, body areas

RÉSUMÉ

Bilton, H. T. 1984. Variation in scales sampled from different body areas of sockeye salmon yearlings (Oncorhynchus nerka). Can. Tech. Rep. Fish. Aquat. Sci. 1297: 7 p.

Des écailles ont été prélevées sur 15 zones corporelles de trois saumons rouges âgés d'un an et capturés dans le lac Babine. Cinq écailles de trois zones, dont le radius et le nombre de circuli ont été quantifiés, ont été examinées au microscope. On a calculé le radius moyen et le nombre de circuli des écailles de chaque partie corporelle. Les résultats indiquent une importante variation de ces caractéristiques. Ainsi, les écailles prélevées sur les zones juste au-dessus de la ligne latérale étaient les plus grosses et possédaient le plus grand nombre de circuli. Parmi ces zones, celle située à mi-chemin entre l'insertion de la nageoire dorsale et l'origine de la nageoire adipeuse possédait les plus grosses écailles contenant le plus grand nombre de circuli. Les écailles échantillonnées dans les zones près des surfaces dorsale et ventrale du poisson étaient plus petites et contenaient moins de circuli. Parmi toutes les écailles, celles de la surface dorsale étaient les plus petites. La zone corporelle possédant les plus grosses écailles fournit probablement les données les plus complètes sur l'âge et la croissance du poisson. Il est donc important, pour les études concernant ces aspects, que seules des écailles prélevées dans cette zone soient utilisées.

Mots-clés: saumon rouge, poisson d'un an, écaille, variation, zones corporelles

INTRODUCTION

In a study of the scales of three specimens of Salmo salar, Esdaile (1912) found great variation in the number of circuli and in the lengths of scales taken from different parts of the same fish. From her examination of the three fish she also found that the number of "annuli" (circuli) in each "peronidium" (one summer plus one winter's scale growth) increased from the head to the adipose fin and then diminished towards the tail. Similarly, she observed a decrease dorsally and ventrally from the lateral line. In a comparison of scales taken from positions at corresponding distances from the head on both the dorsal and ventral side of the lateral line, she found that in general the scales dorsal to the lateral line had fewer circuli in each summer's and winter's growth than the corresponding scales from the ventral side. Esdaile concluded that scales used in comparisons of different fish should all be taken from the same restricted areas. The present study investigates the extent of such variation in scales of sockeye salmon.

MATERIALS AND METHODS

Three preserved yearling sockeye taken from the Babine Lake smolt migration were used for study. From each of these fish, scales were taken from 15 different body areas. Figure 1 shows these in relation to the position of parr marks. Five undamaged and non-regenerated scales from each of these areas were examined under a binocular microscope. The circuli[1] on each of the scales were counted (the first summer's and winter's growth). Measurments with an ocular micrometer (at 40x) were also made along the anterior axis of each scale from the center of the focus to the periphery of the first winter's growth. The average number of circuli and the average scale radius of the 5 scales examined from each of these areas are presented in Table 1.

RESULTS

The results indicate considerable variation in the average number of circuli and the average length of radius of scales removed from various body areas of the same fish (Table 1). Grand averages of circulus number and of scale radius for scales from 15 body areas for all three fish combined are shown in Figure 1. Despite differences in the size of the three fish which in

[1]Circuli are a series of circular corrugations confined mainly to the anterior part of the scale.

turn influence scale size and circulus number, there was still a clear indication of a trend in each of the two scale characters in relation to position on the body.

Average circulus number and length of radius of scales from areas located near the dorsal surface of the fish (Fig. 1, areas 1a to 5a) and from areas located near the ventral surface of the fish (Fig. 1, areas 1c to 5c) were of similar magnitude. However, the values for scales from areas 1a to 5a tended to be consistently lower than for scales from areas 1c to 5c. In both cases (areas, a and c) the trends through areas 1 to 5 were similar. Both circulus number and scale radius increased from area 1 (Fig. 1, located just posterior to the pectoral fin) through to area 4 (Fig. 1, located below and midway between the insertion of the dorsal fin and the origin of the adipose fin). Posterior to area 4 at area 5 (Fig. 1, located below the origin of the adipose fin) the circuli number either decreased as in area 5a, or levelled off as in area 5c. In both cases the scale radius decreased between areas 4 and 5.

Scales taken from areas just above the lateral line (Fig. 1, areas b) were largest in size and had the most circuli. Among these areas, both circulus number and scale radius increased posteriorly from area 1 through to area 4 (Fig. 1, located below and midway between the insertion of the dorsal fin and the origin of the adipose line) and then decreased in area 5, below the origin of the adipose fin.

Scales taken from 15 identical positions on the left and right sides of one fish (the 8.2 cm yearling) were compared for circulus number and scale radius (Table 2). Results indicate that both circulus number and scale radius were very similar between identical areas from the two sides of the fish.

The relationship between average circulus number and average radius of scales taken from the 15 body areas for each of three fish was calculated. The data indicate that within each fish there was a higly significant positive linear correlation between scale radius and circulus number (for the 8.2 cm yearling, $r = 0.94$, $y = 3.05 + 0.28x$; for the 9.0 yearling, $r = 0.97$, $y = 1.54 + 0.312x$, and for the 9.5 cm yearling, $r = 0.97$, $y = 2.22 + 0.27x$).

DISCUSSION

The results indicate considerable variation in scale size and number of circuli among scales from various body areas. However, clear trends were observed for the two scale characters in relation to the body area from which they originated. Scales from just above the lateral line were largest in size and had the most circuli. Among the areas just above the lateral line the greatest scale size and circulus number occurred midway between the insertion of the dorsal fin and the origin of the adipose fin. Scales from areas near

the dorsal and ventral surfaces of the fish had smaller scales and fewer circuli. Those from the dorsal surface had the smallest scales of all. The reasons for the observed differences in the size of scales from different areas of the body of the same fish are not completely understood. Work by Klaatch (1890), Paget (1920), and Neave (1936) suggests that scale formation does not begin uniformly over all the fish's body. Neave cited Klaatch's discription of the formation of the scales of Salmo trutta. According to Klaatch, scales first form in the anterior and median region of the body near the lateral line and then spread ventrally, dorsally and posteriorly. Paget described the scales of Salmo rideus as first appearing along the lateral line, then spreading most rapidly on the middle and posterior parts of the body. Neave found that in Salmo the first papillae appear nearly simultaneously along the anterior and middle regions of the lateral line. However, the regions of most rapid subsequent scale formation seemed to lie farther back than where the papillae first appeared.

If scales first form and grow as quickly and in the same body areas on Oncorhynchus as on Salmo, then the oldest scales would be those which would be the largest and have the most circuli. Hence, the present data suggest that in sockeye, scales probably first form and develop just above the lateral line midway between the dorsal and adipose fins, then spread near the lateral line both towards the head and the tail. From the lateral line area they then spread both dorsally and ventrally along the side of the fish. This sequence would explain the present findings.

These findings are relevant to age and growth studies of sockeye salmon (and probably to other species of Oncorhynchus) where scales are used to estimate these parameters. Because the body area with the largest scales probably provides the most complete record of age and growth of the fish it is important that scales from only this area are used. Futhermore, if comparative estimates of growth and age among individuals of the same species are to be made, it is important that scales are always sampled from the same location.

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Table 1. Average circulus number and scale radius (x40) of scales obtained from various areas of the left sides of three sockeye salmon yearlings.

	Yearling 1 (8.2 cm)				Yearling 2 (9.0 cm)				Yearling 3 (9.5 cm)			
	Circuli		Radius		Circuli		Radius		Circuli		Radius	
Body area	$\bar{x}$	S.E.	$\bar{x}$	S.E.	$\bar{x}$	S.E.	$\bar{x}$	S.E.	$\bar{x}$	S.E.	$\bar{x}$	S.E.
1a	8.6	.244	21.4	.982	9.2	.373	24.6	.242	9.2	.199	26.8	.663
1b	12.4	.244	29.0	1.139	12.4	.373	36.0	1.210	12.8	.489	40.4	1.434
1c	9.2	.489	22.4	.600	8.6	.244	25.8	.582	10.8	.373	33.2	1.031
2a	9.0	.315	22.0	.950	11.4	.244	30.2	.197	10.4	.244	31.6	.677
2b	12.8	.582	33.4	2.112	14.2	.199	42.0	1.049	14.4	.244	45.2	.663
2c	10.2	.199	28.4	.982	11.2	.199	33.6	.928	11.8	.373	37.2	.798
3a	10.2	.435	26.6	.928	12.0	.311	35.0	1.000	12.0	.311	38.6	1.600
3b	13.2	.199	38.6	.748	15.0	.447	44.0	1.735	15.4	.399	50.0	1.094
3c	11.2	.199	31.4	.511	10.8	.199	32.4	.811	12.4	.244	41.0	1.874
4a	11.2	.199	27.0	.838	12.8	.199	35.2	.968	13.2	.373	39.8	1.807
4b	14.2	.373	39.6	.400	16.0	.000	47.8	.860	15.4	.244	50.4	1.506
4c	11.6	.599	30.8	1.430	13.2	.489	37.2	1.896	12.4	.244	39.8	1.717
5a	10.8	.373	26.0	.632	12.8	.199	35.2	1.336	11.6	.244	33.0	.838
5b	12.8	.373	34.0	1.000	15.8	.199	46.6	.811	15.6	.244	48.6	1.251
5c	11.8	.373	31.8	.968	12.6	.244	32.6	.242	12.8	.373	36.2	.968

Table 2. Average circulus number and scale radius (x40) of sales obtained from various areas of the left and right sides of one sockeye salmon yearling 8.2 cm long.

	Left side				Right side			
	Circuli		Radius		Circuli		Radius	
Body area	$\bar{x}$	S.E.	$\bar{x}$	S.E.	$\bar{x}$	S.E.	$\bar{x}$	S.E.
1a	8.6	.244	21.4	.982	8.0	.311	18.6	.399
1b	12.4	.244	29.0	1.139	10.4	.399	27.0	1.345
1c	9.2	.489	22.4	.600	8.2	.199	21.8	.735
2a	9.0	.315	22.0	.950	8.4	.244	22.6	.244
2b	12.8	.582	33.4	2.112	12.4	.489	35.4	.399
2c	10.2	.199	28.4	.982	10.0	.311	29.8	.373
3a	10.2	.435	26.6	.928	11.0	.000	28.8	.582
3b	13.2	.199	38.6	.748	14.3	.399	37.8	.488
3c	11.2	.199	31.4	.511	10.6	.244	30.2	.199
4a	11.2	.199	27.0	.838	11.2	.199	29.0	.896
4b	14.2	.373	39.6	.400	14.0	.000	40.0	.000
4c	11.6	.599	30.8	1.430	11.0	.000	29.6	.511
5a	10.8	.373	26.0	.632	10.8	.199	25.6	.869
5b	12.8	.373	34.0	1.000	12.8	.373	34.8	1.856
5c	11.8	.373	31.8	.968	10.4	.244	27.8	.735

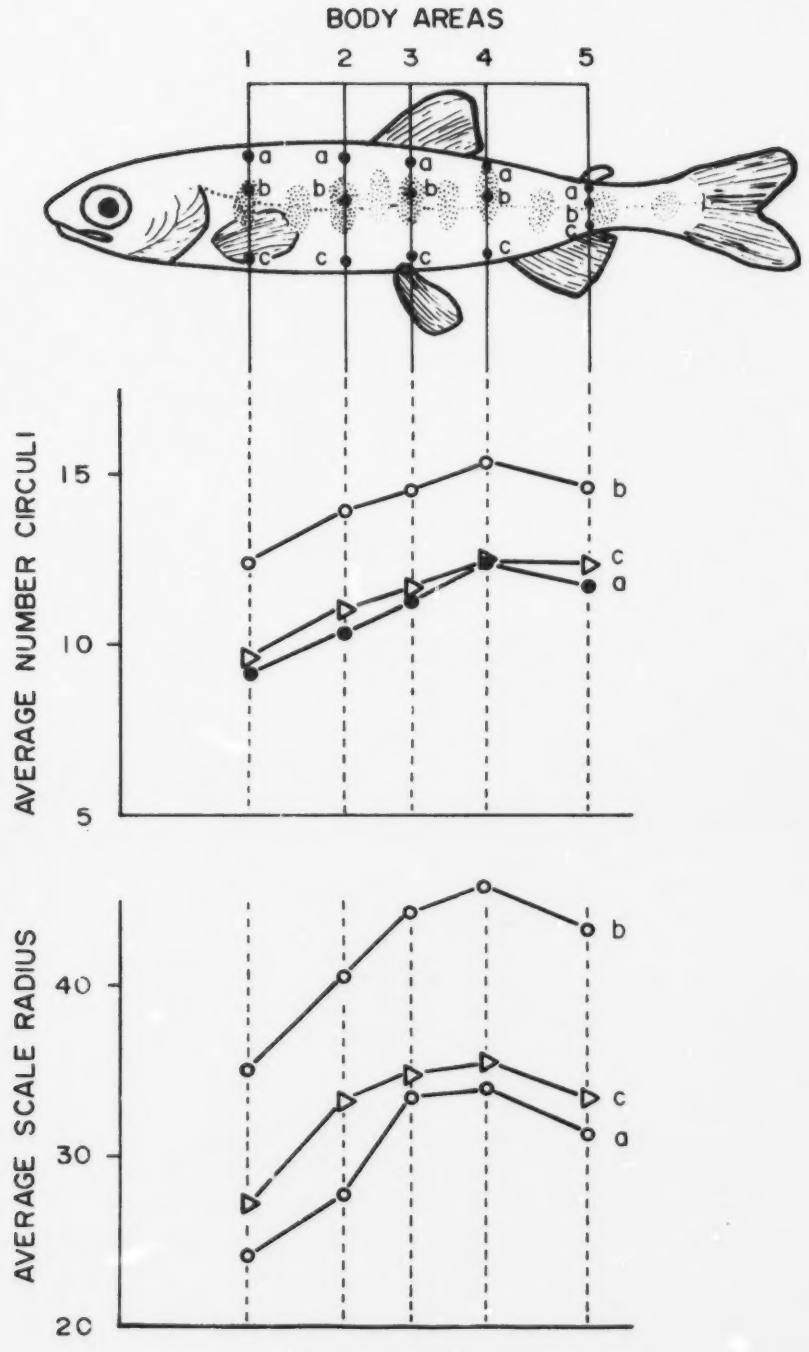

Fig. 1. Grand average circulus number, and grand average scale radius (millimeters) of scales taken from 15 areas of the left side of three sockeye yearlings from Babine Lake, 1956.